Exploration Ground Systems

Advanced Ground Systems Maintenance Anomaly Detection (AGSM)

Completed Technology Project (2011 - 2016)

Project Introduction

The Inductive Monitoring System (IMS) software utilizes techniques from the fields of model-based reasoning, machine learning, and data mining to build system monitoring knowledge bases from archived or simulated sensor data. Unlike some other machine learning techniques, IMS does not require examples of anomalous (failure) behavior. IMS automatically analyzes nominal system data to form general classes of expected system sensor values. This process enables the software to inductively learn and model nominal system behavior. The generated data classes are then used to build a monitoring knowledge base. In real-time,

IMS performs monitoring functions, determining and displaying the degree of deviation from nominal performance. IMS trend analyses can detect conditions that may indicate a failure or required system maintenance. The development of the IMS was motivated by the difficulty of producing detailed diagnostic models of some system components due to complexity or unavailability of design information.

This project will develop the capability to identify anomalous conditions (indications to potential impending system failure) in ground system operations before such failures occur. These indicators are not presently detectable by traditional command and control and fault detection systems. This project enables the delivery of system's health advisories to ground system operators so they can take action prior to experiencing systems failures. Inductive Monitoring System (IMS) detected anomalies can be sent to a diagnostic software module for diagnosis.

Anomaly Detection provides the 21st Century Launch Complex Program with the ability to identify/recognize systems' anomalies before they become faults in the system; it supports the resolution of such anomalies to assure system availability and mission success. This capability also allows reduction in systems' maintenance costs by dictating when maintenance is needed (Maintenance-on-Demand) versus performing maintenance on schedule.

Anticipated Benefits

Anomaly Detection can lead to early intervention, prevent further system damage, and reduce remediation cost and effort. Additional information would be provided to the console operators, which components are suspect will reduce the time required to assess the situation and provide a recommendation.

This technology supports formulation of maintenance "on-need" instead of a scheduled maintenance approach; and also supports requirements to train personnel on system function in nominal and off-nominal operation.

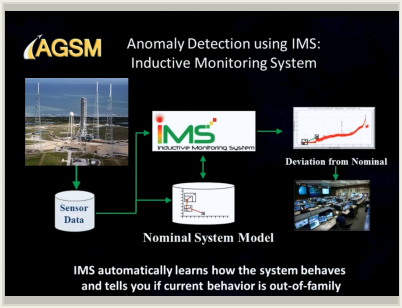

Diagram of Anomaly Detection using IMS

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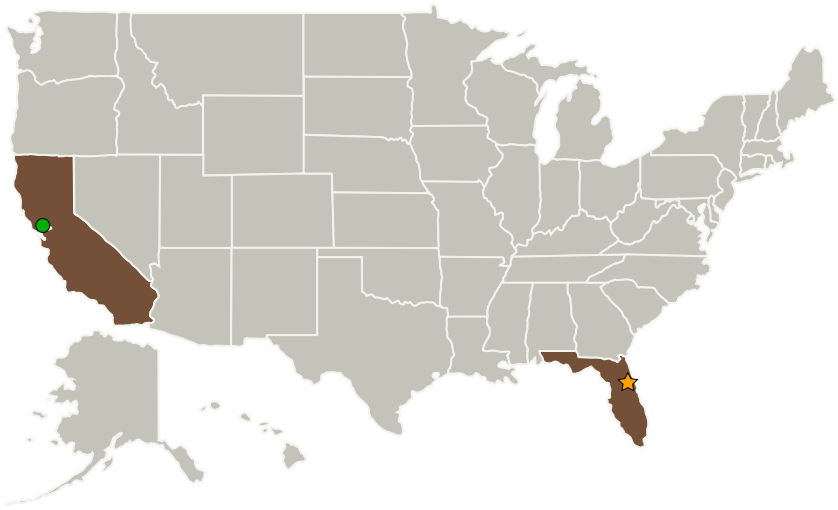
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Kennedy Space Center(KSC)	Lead Organization	NASA Center	Kennedy Space Center, Florida
Abacus Technology Corporation	Supporting Organization	Industry Small Disadvantaged Business (SDB)	
●Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California
QinetiQ North America(QNA)	Supporting Organization	Industry	
Stinger Ghaffarian Technologies(SGT)	Supporting Organization	Industry	

Organizational Responsibility

Responsible Mission Directorate:

Exploration Systems Development Mission Directorate (ESDMD)

Lead Center / Facility:

Kennedy Space Center (KSC)

Responsible Program:

Exploration Ground Systems

Project Management

Program Managers:

Thomas D Whitmeyer
Michael J Bolger

Project Manager:

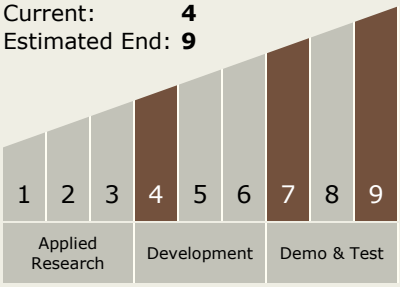
Barbara L Brown

Principal Investigator:

Barbara L Brown

Technology Maturity (TRL)

Start: **7**
Current: **4**
Estimated End: **9**



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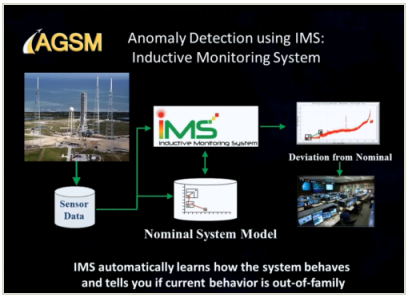
Primary U.S. Work Locations	
California	Florida

Images



Anomaly Detection using Inductive Monitoring System
Diagram of Anomaly Detection using IMS
(https://techport.nasa.gov/image/2083)

Links

Inductive Monitoring System - Automated Monitoring Techniques for Complex Systems
(http://www.nasa.gov/pdf/561488main_IMS.pdf)

Technology Areas

Primary:

- TX13 Ground, Test, and Surface Systems
  - TX13.4 Mission Success Technologies
    - TX13.4.5 Operations, Health and Maintenance for Ground and Surface Systems